

THE INCREASING URBAN TEMPERATURE AND THE COMMUNITY'S ADAPTATION TO THE HEALTH RISK IN HO CHI MINH CITY

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ABSTRACT

Under impact of urbanization, temperature in Ho Chi Minh City has been continuously increased by time and it negatively affected people's health. The focus of study was to identify perception of people on the relationship between the heat and diseases together with their responses. This quantitative and qualitative research was to analyze the social vulnerability of households, people's perception on health risks, diseases in family and adaptive behavior of people on high temperature and diseases. This study was conducted in 6 districts represented the three areas with different levels of urbanization. The findings show that cardiovascular disease and respiratory disease were recognized as the high temperature-related diseases by local people. The city people performed many measures to adapt to high temperature in their daily activities. To reduce health risks caused by the high temperature, the solutions had to cover all aspects of urban planning and management, living-condition improvement to urban poor communities, and enhancement of preventive health activities.

KEYWORDS: High Temperature, Urban Heat Island, Urbanization, Climate Change, Respiratory Diseases and Diarrhea

INTRODUCTION

Ho Chi Minh City (HCMC) is the special-class city, the biggest center of economics, cultural and education, technology and science of Vietnam. Its population was about 7.7 million persons in 2012. It has the biggest scale of population and the highest rate of urbanization (about 83.2 percent) in Vietnam (GSO, 2012).

The city is in the subequatorial and tropical monsoon climate with two separately rainy and dry seasons. The average temperature is from 27°C to 28°C, and the maximum vibration amplitude of temperature between the coldest and hottest month of a year is about 4°C to 5°C. In recent years, along with urbanization, city becomes warmer. The monitored data from the Southern Regional Hydrometeorological Center in HCMC (SRHMC, 2012) showed the many-year-average of surface temperature of HCMC proximately increased 1°C (from 27.1°C to 28.1°C) in the period of 1984-2012.

The warmer environment has increasingly caused the seriousness of the chronic diseases including cardiovascular disease and respiratory diseases (Gross, 2002; The Centers for Disease Control and Prevention of the United States-CDC, 2010). According to Vietnam Ministry of Natural Resources (MoNRE) (2008), the increase of temperature and humidity in the atmosphere have induced the pressure of temperature to human body, especially to elderly and children, and caused the tropical and communicable diseases through the intermediary factors as bacterium, insects and vectors, malnutrition and the low-quality environment.

Literature review of research group in Viet Nam suggested that there was almost no study on the health risks related to the increase of temperature and the adaptative behavior of urban communities in especially. This research therefore was carried out to fill the gap of this field and to contribute the useful information to the preventive health programs in order to assist people to cope more effectively to the change of climate.

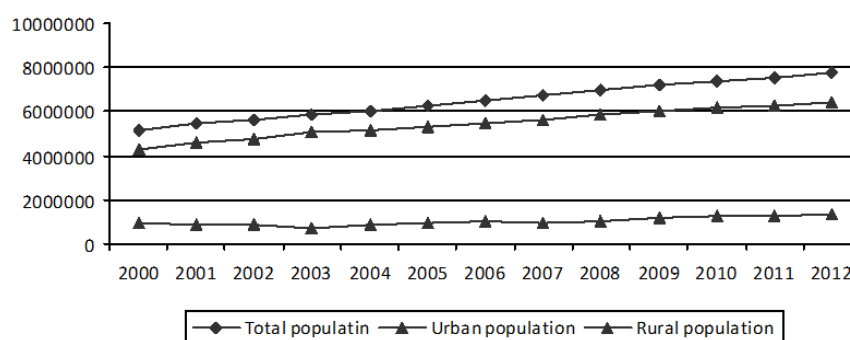
RESEARCH METHODOLOGY

This research used the design of descriptive survey study with the gathering of both primary and secondary data. Information of primary data included people's perception on the urban increasing temperature and diseases, self-report of households of their diseases and their preventive behavior to the health risk. Primary data was collected by structured questionnaire with interviewing of 800 representatives of household. The spatial hierarchy sampling was used. Firstly, the 6 of 24 districts of HCMC represented the three areas with different levels of urbanization were selected. Those are District 1 and 3, and Binh Thanh District represented the urban center where urbanization is stabled; District 2 and Binh Tan District represented the sub-urban area where urbanization is occurring strongly; Binh Chanh district represented the sub-urban area where urbanization just start. Secondly, in each district, one lowest-income and one highest-income sub-district were chosen. For further information on household's perception of diseases, 10 households were chosen for the semi-structured interviews. The secondary data consisted of reports, papers, and documents, etc. about the health problems related to the increasing temperature. Other statistic data was from the Department of Health in HCMC. The questionnaire data was input in SPSS version 16.0. And the descriptive statistics and Chi-square test were used in the analyzing process.

RESULTS AND DISCUSSIONS

The Urbanization, the Increasing Temperature, and the Health Problems in Ho Chi Minh City

In 2000-2012, due to urbanization, the total population and urban population of HCMC have trended to increase by time (see Figure 1). This increase was mostly by the immigration flows from the neighbor provinces to HCMC. In 2012, the natural increase rate was 18.9 per thousand, and the net-emigration rate was 9.6 per thousand (GSO, 2012).



Source: General Statistic of Vietnam - GSO in 2000-2012

Figure 1: Ho Chi Minh City Population in 2001-2012

The urbanization and associated population growth has caused the land-use change for urban development. It resulted in the serious changes of water surface and the sealed area in HCMC (see Figure 2). In period of 1985-2010, there were about 50,000 hectares of canals and ditches, wetland, and infiltration areas replaced by the sealed surface (GIZ, 2013). According to the land-use plan, the sealed area HCMC would be increased from 21 percent in 2015 to 32 percent in 2025 (Storch et al., 2011).

The rapid expansion of built-up area has led the decrease of green space in HCMC. In 2010, the areas of green parks, flower gardens, and green trees in urban area were 535 hectares compared to 1000 hectares in 1998 (reduced nearly 50 percent within 12 years). Consequently, the rate of green space per person was proximately 2 square meters per person, only about one-tenth of the green space per person in the world-modern cities (about 20 to 25 square meters per person) (The HCMC Park and Green Tree Company, 2010). Besides, the population growth has caused the increasing use of motor vehicles, air-conditions, and high-energy-using appliances for cooling, etc. In the period of 2000-2011, the number of car automobiles increased from 131,000 to 493,300 vehicles; and the number of motorbikes increased from 1,571,000 to 5,519,000 vehicles (GSO, 2012).

The above urbanization consequences have induced the increase of temperature in the city. In 2002-2010, temperature zone of 25-30°C and 30-35°C were strongly increased, and cooler temperature zone of 25-30°C was strongly decreased. In comparison to the previous period of 1995-2002, the zone of 25-30°C was lightly increased, the zone of 25-30°C was lightly decreased, and zone of 30-35°C was not happened (Luu & Nguyen, 2012). It showed that the city temperature increase strongly in period of 2002 - 2010 compared to period of 1995 - 2002. In the central area of the city, the temperature is 11°C- 12°C higher than the outside areas because of the urban-heat-island (UHI). The UHI covered almost 29,000 hectares of the central districts. The reason is that here there is a dense concentration of urban infrastructure, construction works and housing, poor air convection, high energy consumption for transportation, industrial and living activities and lack of green space and surface water as well (Tran et al., 2011). In the near future, city people would face to the extremely weather. In which, the temperature would be increased by the impacts of climate change. In forecast, the annual average temperature of HCMC would increase 0.5°C in 2020, 1.4°C in 2050, and 2.7°C in 2100 compared to previous period of 1980-1999, especially there would be more the number of extremely hot days over 35°C (MoNRE, 2012). This forecast excludes the impact of UHI that has an important contribution to current warming and its intensity could increase in the case of urbanization continues to take place in the city.

In the context of the city temperature increasing and more heat, more types of diseases have occurred in the city, especially diseases transmitted by mosquitoes (such as dengue fever), diseases transmitted by food (such as food poisoning), disease transmission through water (mainly intestinal diseases, skin diseases), hand, foot and mouth disease, respiratory illnesses (such as upper respiratory infections, pharyngitis, pneumonia) and non-communicable diseases (as cardiovascular disease) etc. (Le, 2006). There were four diseases chosen to analyze in this research: cardiovascular disease, respiratory infection, dengue, and diarrhea. These are the typical diseases by increasing temperature in the dry season in HCMC. The statistics in 2001-2010 counted on 10,000 people, the rate of persons who had hearth diseases, respiratory infection, and dengue trended to increase. In contrary, the rate of persons who had the diarrhea trended to decrease (see Table 1).

Table 1: The Incidence of Cardiovascular Disease, Respiratory Disease, Dengue Fever and Diarrhea Per 10,000 People in the 2001-2010 Period in HCMC

Type of Disease	In 2001	In 2010	Average Increase/Decrease Per Year
Cardiovascular disease	6.27	12.59	+ 0.70
Respiratory disease	15.70	22.18	+ 0.72
Dengue	0.52	1.37	+ 0.09
Diarrhea	0.43	0.19	- 0.03

Source: HCMC Department of Health (2001-2010)

The Socioeconomic Characteristics of the Sample Population

The data from household survey of this research showed these households had the long-living in their areas, about 21 years in average. And the average numbers of immigration households were 20.2 percent. The immigration rates of households in the rural districts and sub-urban districts (27.3 percent and 25.3 percent) were higher than in the center-stabled-urbanized districts (14.7 percent). The sample population had the low level of socioeconomic characteristics. Their main commonly occupation were small sellers, workers, and government officials. And their average income was 2.2 million Vietnam Dongs per person per month. In comparison to the HCMC poverty line (below 1 million Vietnam Dong per person per month), the poor households in the survey were 23.4 percent. Housing is the important characteristic related to the people health. The survey result indicated there were about 40.4 percent of households living in the semi-detached and temporarily-built houses. The households in the rural and suburban live in lower quality of housing (54 percent and 50.2 percent. respectively). About the housing daylight and ventilation, there were 25.1 percent of houses with not enough daylight, 31.1 percent of houses with no ventilation, and 31.4 percent with high temperature in the houses. The main reason for these problems was these houses had no windows enough for inside ventilation. At the research field, the poor households had to reduce the numbers of windows to reduce cost for housing building. Therefore, they are highly vulnerable to their health risks rather than other population groups in the city.

Table 2: The Socio-Economic and Settlement Characteristics and Sanitation Facilities of Households

		Settlement Area						Total	
		Rural		Suburban		Urban Center		n	%
		n	%	N	%	n	%		
Settlement status	Permanent	93	72.7	201	74.7	344	85.4	638	79.8
	Temporary	35	27.3	68	25.3	59	14.7	162	20.2
Total		128	100.0	269	100.0	403	100.0	800	100.0
Number of Year Living in Local		Mean = 17		Mean = 17		Mean = 24		Mean = 21	
Main occupation for main income	Selling	41	32.0	114	42.4	146	36.2	301	37.6
	Worker	12	9.4	35	13.0	32	7.9	79	9.9
	Government official	42	32.8	91	33.8	148	36.7	281	35.1
	Service	9	7.0	11	4.1	28	6.9	48	6.0
	Retirement pension	24	18.8	18	6.7	49	12.2	91	11.4
Total		128	100.0	269	100.0	403	100.0	800	100.0
Monthly average income	One million VND and below	27	22.9	61	22.9	96	23.9	184	23.4
	Above one million VND	91	77.1	205	77.1	305	76.1	601	76.6
Total		118	100.0	266	100.0	401	100.0	785	100.0
		Mean = 2.1		Mean = 2.4		Mean = 2.1		Mean = 2.2	
Current housing type	Detached	59	46.1	134	49.8	284	70.5	477	59.6
	Semi-detached	61	47.7	121	45.0	116	28.8	298	37.3
	Temporarily house	8	6.3	14	5.2	3	.7	25	3.1
Total		128	100.0	269	100.0	403	100.0	800	100.0
Inside daylight	Redundant	93	72.7	192	71.4	314	77.9	599	74.9
	Not enough	35	27.3	77	28.6	89	22.1	201	25.1
Total		128	100.0	269	100.0	403	100.0	800	100.0
Inside temperature	Cool temperature	85	66.4	186	69.1	278	69.0	549	68.6
	Hot temperature	43	33.6	83	30.9	125	31.0	251	31.4
Total		128	100.0	269	100.0	403	100.0	800	100.0
Inside ventilation	Ventilated	80	62.5	150	55.8	321	79.7	551	68.9
	Unventilated	48	37.5	119	44.2	82	20.3	249	31.1
Total		128	100.0	269	100.0	403	100.0	800	100.0

Table 2: Contd.,

Drainage	Hygienic	50	39.1	143	53.2	343	85.1	536	67.0
	Unhygienic	78	60.9	126	46.8	60	14.9	264	33.0
Total		128	100.0	269	100.0	403	100.0	800	100.0
Solid waste treatment	Collection service	90	72.0	261	97.4	398	98.8	749	94.1
	Bury, burn	35	28.0	7	2.6	5	1.2	47	5.9
Total		125	100.0	268	100.0	403	100.0	796	100.0
Outside sanitation	Clean	86	67.2	186	69.1	379	94.0	651	81.4
	Unclean	42	32.8	83	30.9	24	6.0	149	18.6
Total		128	100.0	269	100.0	403	100.0	800	100.0

The environmental sanitation has the significant effects to arise or reduce the communicable diseases. The results indicated the households in rural had less using of solid-waste collection service and better drainage system than households in suburban and urban center. Besides, the bad environment outside the houses (such as flooding and solid waste) in periphery and suburban (32.8 percent and 30.9 percent) worse than in urban center (6 percent). In consequence, households in rural and suburban faced to higher risk of health problems.

Perception of Health Risks Caused by High Temperature

The ways that people perceive on temperature variations in their residential place and its connection to diseases is particularly important as it affects capacity of people in developing appropriate coping strategies. Results in Table 3 showed that the majority of people state their residence trended to be warmer over time. The Chi-square testing showed there was significant difference of that feeling between urbanized areas ($\chi^2 = 69.875$, $P = 0.000$). In which, the rate of households stated that their residence become warmer was highest in the urban center where suffer the most UHI (80.9 percent) and lowest in the rural area (46.9 percent).

Table 3: Temperature Variation in Residential Area and Relationship between Heat and Cause of Diseases

		Settlement Area						Total	
		Rural		Suburban		Urban Center		n	%
		n	%	n	%	n	%		
Temperature in residence	Warmer	60	46.9	155	57.6	326	80.9	541	67.6
	The same	68	53.1	114	42.4	77	19.1	259	32.4
Total		128	100.0	269	100.0	403	100.0	800	100.0
Relation between heat and disease	Have	75	58.6	209	77.7	331	82.1	615	76.9
	Have no	53	41.4	60	22.3	72	17.9	185	23.1
Total		128	100.0	269	100.0	403	100.0	800	100.0
Relation between heat and cardiovascular disease	Have	91	71.1	206	76.6	252	62.5	549	68.6
	Have no	37	28.9	63	23.4	151	37.5	251	31.4
Total		128	100.0	269	100.0	403	100.0	800	100.0
Relation between heat and cause of respiratory disease	Have	65	50.8	192	71.4	263	65.3	520	65.0
	Have no	63	49.2	77	28.6	140	34.7	280	35.0
Total		128	100.0	269	100.0	403	100.0	800	100.0
Relation between heat and cause of dengue	Have	28	21.9	44	16.4	74	18.4	146	18.3
	Have no	100	78.1	225	83.6	329	81.6	654	81.7
Total		128	100.0	269	100.0	403	100.0	800	100.0
Relation between heat and cause of diarrhea	Have	56	43.8	117	43.5	133	33.0	306	38.3
	Have no	72	56.3	152	56.5	270	67.0	494	61.7
Total		128	100.0	269	100.0	403	100.0	800	100.0

People stated that there was a relationship between the heat and disease (76.9 percent). There was significant difference of this statement between urbanized areas ($\chi^2 = 30.435$, $P = 0.000$), in which the rate of households agreed with this statement was highest in the urban center and lowest in the rural area (82.1 percent and 58.6 percent, respectively). According to residents, the cause of cardiovascular disease and respiratory disease was associated with high temperature (68.6 percent and 65.0 percent, respectively). For the dengue and diarrhea, in contrast, most people thought that high temperature was not relevant (81.7 percent and 61.7 percent, respectively).

Results of in-depth interview showed how higher temperatures led to sickness arising residents were explained as follows:

- Heat condition forced people implementing health risk behaviors such as baths so much, felt anorexia, insomnia.
- High temperature made the individual having extreme psychological states such as stress. The psychological disorder will lead to biological disorder.
- High temperature raised blood pressure, stress, headaches, and fatigue which led to cardiovascular disease
- The heat made the environment more dust, people drinking a lot of ice, shortness of breath, suffocating, lack of oxygen and these were the causes of respiratory disease.
- High temperature created conditions for spread of dengue mosquitoes. And
- The heat easily spoiled food and people used to get diarrhea as they exposed to it.

Disease in Household

In HCMC, the dry season is the season with the highest temperature of the year and the peak of heat starting in March and lasts until mid-May. At that time, result of survey showed that 28.1 percent of households reported their members having respiratory disease, 12.5 percent of households having cardiovascular disease, 8.5 percent of households having diarrhea and 8.1 percent households having dengue. The incidence of cardiovascular disease, respiratory disease, dengue and diarrhea in the research community were respectively 265.1, 596, 172.3 and 180 per 10,000 people. Therefore, respiratory disease is the principal local risk.

Table 4: Self-Reported of Disease Rate by Settlement Area

	Settlement Area						Total	
	Rural		Suburban		Urban Center		n	m
	n	%	n	%	n	%		
Cardiovascular disease	12	9.4	21	7.8	67	16.6	100	12.5
Respiratory disease	29	22.7	93	34.6	103	25.6	225	28.1
Dengue	15	11.7	41	15.2	9	2.2	65	8.1
Diarrhea	11	8.6	29	10.8	28	6.9	68	8.5

There was significant difference of types of main diseases reported by households between various urbanized areas. In which, self-reported cardiovascular disease rate was highest in urban center. ($\chi^2 = 12.831$, $P = 0.002$). Self-reported respiratory disease and dengue rates were highest in suburban ($\chi^2 = 8.739$, $P = 0.013$ và $\chi^2 = 39.205$, $P = 0.000$, respectively). And dengue had the highest self-reported rate in rural area.

The types of diseases reported by households were associated with their specific residential places. In urban center, although quality of life was better than other areas such as having many job prospects, food diversity, sufficient health care system and other urban services but people here also faced many health risks due to urgent lifestyle, unreasonable nutrition (such as high-fat diet from meat, eggs, milk and salt intake), habit of less exercise, environmental pollution, etc., These were prerequisites of occurrence of non-communicable, especially cardiovascular disease. Suburban was under the urbanization process characterized by the insufficient infrastructure, many construction works and bad environmental sanitation condition. Consequently, living environment here was most polluted and creates condition for the spread of respiratory disease and dengue. While, the rural was an area often lack of sanitation facilities and therefore, diarrhea was more popular than urban center and suburban (Pham, 2009). As Wisner and Adams (2002) note, poor urban areas are particularly vulnerable because characteristics of hazard exposure, environmental conditions, livelihood assets and hygiene behaviour typically conspire to heighten health risks. Chi-square testing showed that poor households had the higher rate of respiratory diseases and dengue than the others (Table 5).

Table 5: Rate of Diseases by Poor Status

Types of Diseases	Poor Households (%)	None Poor Household (%)	Note
Cardiovascular disease	14.1	12.0	$\chi^2 = 3.296$, P= 0.256
Respiratory disease	33.7	26.6	$\chi^2 = 3.475$, P= 0.039
Dengue	12.0	7.2	$\chi^2 = 4.277$, P= 0.031
Diarrhea	12.0	7.7	$\chi^2 = 3.296$, P= 0.051

The Health Risk Prevention

Adaptation to the Heat Status

The results showed that the "Using fan or air-conditioner" was most used by the households (85.9%) as this was a direct impact measure to reduce heat. Other cheaper and easier measures with less impact on the environment were less concerned by the households, such as shower taking (60.1 percent); water drinking (56.4 percent); fruit eating (51.1 percent); and thin-clothes wearing (48.1 percent). Besides, to minimize heat effects, 33 percent of interviewees adjusted their daily travel by limiting to go outside in midday sun.

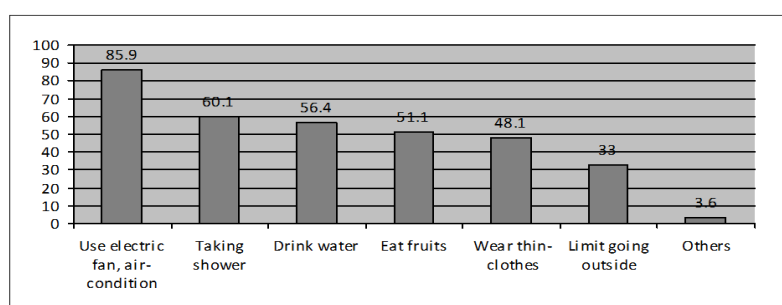


Figure 3: Measures to Reduce the Heat Affects

Other measures (3.6 percent) the households had used such as moving out to the rural area, "This summer is too hot. I have to let my wife and children going to the rural to flee the hot weather. All family member sleep in the few-square-meter room, how can we stand (Case 1, Binh Thanh District)"; Increasing moisture in the room, "The most effective way is to generate cool-air in the room by soaking the blanket in water and hang it up the ceiling (Case 2, Tan Phu District)"; Using drugs, "In the hot season, it is better to drink vitamin C to increase immunity to disease

and illness (Case 5 – Distric 1)". These behaviors might be seen as coping mechanisms of the people in terms of both preventing and adapting to extreme weather events. Although these responses were dynamic but they were short-term and temporary in the nature. Therefore, the concern and support of municipal functional agencies was recognized the necessary undertaking that should be implemented in the next time.

Disease Prevention

In general, the simple behaviours to disease prevention in the dry season (mainly related to respiratory disease, intestinal disease and dengue) recommended by the Center of Preventive Health, were regularly applied by the households and the regular performance rate ranging from 52.5 percent to 98.6 percent (see Table 6). Of interest to research group was to identify preventive behaviors that people often do not perform regularly. Based on the rate of irregular performance of behaviour, preventive behaviors in this study were relatively classified into four groups. Group one composes of preventive behaviours with the very low-level rate of irregular performance (below 10 percent), including "Drinking clean and boiled water" (1.4 percent), "Cleaning the house" (4.6 percent), "Cleaning hands with soap" (6.6 percent) and "Eating well-cooking food, limiting with undercook food" (8.0 percent). Group two composes of preventive behaviours with the low-level rate of irregular performance (from 11 to 20 percent), including "Not using dirty water" (11.3 percent) and "Using mask when going out" (12.7 percent). Group three composes of preventive behaviours with the high-level rate of irregular performance (from 21 to 30 percent), such as "Eating less vendor's food" (25.3 percent) and "Cover the water containers" (25.7 percent). Group four composes of preventive behaviours with the very high-level rate of irregular performance (above 30 percent), such as "Not using much ice-water in hot weather" (47.5 percent). Thus, the behaviours in group three and four should be considered and adjusted in the near future. The low level of performance of group three and group four is related to environmental, social and cognitive factors. "Drink ice water" is related to the habit of using ice in every kind of drink. This habit is a common and long-standing practice for the people in HCMC and is considered adaption to the existence of high temperature all year round here. "Eating vendor's food" is related to the way of food use of the people living in the context of urbanization. According to WHO (2002), eating away from home is not only related to economic development, but also to urbanization: the mobile carts of street vendors have become the fast-food restaurants of the urban poor. It is also related to a shift in work environment, e.g. working outside the home vs. a domestic role. "Do not cover up water containers" reflects people's perception of mosquito breeding sites. People believe that only dengue mosquitoes breeding in dirty water but not in clean water, so there is no need to cover up the water containers (Tran, 2009). These findings emphasized that health communication contents were not only to focus on the health side but also to pay more attention to people's belief, perception and daily activity.

Table 6: The Disease Preventive Behaviour of Households

Preventive Behaviour	Perform Regularly (%)	Perfom Irregular (%)	Total (%)
Cleaning hands with soap	93.4	6.6	100
Drinking clean and boiled water	98.6	1.4	100
Eating less vendor's food	74.7	25.3	100
Not using much ice-water in hot weather	52.5	47.5	100
Using mask when going out	87.3	12.7	100
Not using dirty water (bathing, swimming, playing)	88.7	11.3	100
Cleaning the house	95.4	4.6	100
Cover the water containers	74.3	25.7	100
Eating well-cooking food, limiting with undercook food	92.0	8.0	100

CONCLUSIONS

Increasing temperature in HCMC was the outcome of urbanization. The urban center has higher temperature than the outside areas because of the urban-heat-island. Increasing temperature had the negative impacts on human health. People in HCMC perceived the hot condition is increasing and believed that there was relationship between the respiratory disease and respiratory disease to the increasing temperature. Rising and transmitting of diseases caused by high temperature had the relationship to the different urbanized process of the areas. Cardiovascular disease was mainly happened in urban center. While respiratory disease and dengue were widespread in suburban and the main one in the urban center while respiratory disease located in the suburban area and diarrhea was widespread in rural. Poor households had more vulnerabilities of health than other households. People had actively carried out solutions to respond to the heat although they are short-term and temporary ones. Disease prevention recommended by the health sector was regularly applied by the households and some of preventive behaviours still have constraints as they face to environmental, social and cognitive factors.

SUGGESTIONS

To reduce the health risks caused by increasing temperature, this research had the suggestions focused on three solutions: (1) To reduce the high temperature in urban areas, it should increase the quantity and quality of green space, increase the area of lakes and ponds, reduce the numbers of private transport means by increasing of public transportation with low-energy-using or bio-energy, apply the low thermal conductivity materials in building; (2) To enhance the activities of preventive health by investing and building capacities to the preventive health; and (3) To improve the living environment of poor communities in suburban and rural to enhance their preventive capability of health problems.

REFERENCES

1. Centers for Disease Control and Prevention of the United States-CDC (2010), Health Effects. Retrieved from <http://www.cdc.gov/climateandhealth/effects/>
2. Department of Health of Ho Chi Minh City, health statistics of diseases in the period 2001-2010
3. Department of Statistics of Ho Chi Minh City (2013). Socio-economic characteristics of Ho Chi Minh City in the period 2001-2010.
4. Gross, J. (2002). The severe impact of climate change on developing countries. *Medicine & Global Survival* 7(2): 96-100.
5. Ho Chi Minh City Park and Green Tree Company (2010), Indicator of tree in Ho Chi Minh City. Retrieved from <http://congvien cayxanh.com.vn/> on 25/11/2010.
6. Le, T. H. (2006). Nắng nóng dễ bị bệnh gì? Retrieved from <http://www.khoahoc.com.vn/doi song/yhoc/suc-khoe/4755 nang-nong-de-bi-benh-gi.aspx> on 13/4/2006
7. Luu, D. H., Nguyen T. N. K. (2012). Application of GIS and remote sensing in analyzing the distribution and change of temperature and land surface in Ministry of Natural Resource and Environment. Retrieved from <http://www.khoahocphothong.com.vn/>

8. Ministry of Natural Resource and Environment-MoNRE. (2008). National target program of climate change, pp. 11.
9. Ministry of Natural Resource and Environment-MoNRE. (2012). Scenarios of climate change and sea level rise in Viet Nam. Publisher Natural resources and environment and mapping. Ha Noi, Viet Nam.
10. Pham, G. T. (2009). The impact of urbanization to the changes of environment and diseases in Ho Chi Minh City – period 1990-2007. University of Social Science and Humanity. Viet Nam National University – Ho Chi Minh City, pp.135-137
11. Southern Regional Hydrometeorological Center (SRHMC). (2012). Ho Chi Minh City is warmer! Retrieved from <http://www.kttv-nb.org.vn/>
12. Storch, H., Downes, N. et al. (2011). A scenario-based approach to assessing the exposure and flood risk of Ho Chi Minh City's urban development strategy in times of climate change. Ispra: EnviroInfo 2011: Innovations in Sharing Environmental Observations and Information.
13. Tran, T. V., Lai, T. T., et al. (2011). Research of the change of landsurface under the impact of urbanization in Hochiminh city by remote sensing method. Journal of sciences of earth, pp. 347-359.
14. World Health Organization-WHO (2002), Globalization, diets and noncommunicable diseases, pp.3
15. Wisner, B., Adams, J. (eds). (2002): Environmental health in emergencies and disasters. Geneva: World Health Organization.